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(54) Resin compositions.

(57) A resin composition comprising a resin (1) comprising 5 to 95% by weight of a polyphenylene oxide and 95 to 5% by weight of a polyamide and (2) 0.01 to 30 parts by weight of (A) a liquid diene polymer, (B) an epoxy compound or (C) a compound having in the molecule both (a) an ethylenic carbon-carbon double bond or a carbon-carbon triple bond and (b) a carboxylic acid, acid anhydride, acid amide, imido, carboxylic acid ester, amino

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## RESIN COMPOSITIONS

1       The present invention relates to resin compositions comprising polyphenylene oxide, polyamide and a compound having a specified structure.

      A polyphenylene oxide is a resin having  
5   excellent thermal, mechanical and electrical properties, and commercially it is blended with a polystyrene and put on the market as Noryl resin by General Electric Company. But, polyphenylene oxide and its modified product, Noryl resin, have a drawback that they are  
10   poor in solvent resistance, and therefore their use for certain usages is limited at present irrespective of their excellent other characteristics. The improvement of the drawback is therefore strongly desired.

      For the reasons as described above, the  
15   inventors extensively studied to develop a polyphenylene oxide having an improved solvent resistance without doing a great damage to the characteristics of the resin. As a result, it was found that such the resin can be obtained by melt-blending a polyphenylene oxide  
20   and a polyamide in a specified mixed ratio. The resin composition thus obtained shows no phase separation on processing and has excellent solvent resistance, but it is a little poor in impact resistance in certain usages. As a result of a further study to improve this  
25   drawback, the inventors found that the melt-blended

1 product of a mixture of polyphenylene oxide, polyamide  
and a compound having a specified structure is superior  
in mechanical properties such as impact resistance to  
the aforesaid melt-blended product of a simple mixture  
5 of polyphenylene oxide and polyamide.

The reason why the resin composition obtained  
according to the present invention is superior in  
mechanical strength to the melt-blended product of a  
simple mixture of polyphenylene oxide and polyamide,  
10 is not clear. From the electron microscopic observation  
of both resin compositions, however, it is presumed  
that graft reaction has probably taken place between  
polyphenylene oxide and polyamide in the case of the  
resin composition of the present invention. Because  
15 it is observed that both polyphenylene oxide region and  
polyamide region of the present resin composition are  
in a markedly fine disperse state as compared with the  
simple mixture.

For the purpose of giving impact resistance to  
20 a resin, a method of blending the resin and a rubbery  
polymer is frequently employed in general. But, a  
composition comprising polyphenylene oxide, polyamide  
and a rubbery polymer showed a low impact resistance.  
The inventors found, however, that the impact resistance  
25 of the composition can be improved by adding a compound  
having a specified structure. The inventors thus  
attained to the present invention.

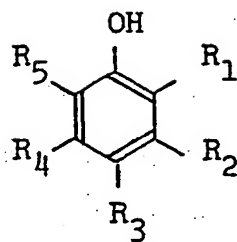
An object of the present invention is to

1 provide a polyphenylene oxide/polyamide composition  
superior not only in solvent resistance but also in  
impact resistance. Other objects and advantages of the  
present invention will become apparent from the follow-  
5 ing description.

According to the present invention, there is  
provided a resin composition comprising a resin  
composition comprising 5 to 95 % by weight of poly-  
phenylene oxide and 95 to 5 % by weight of polyamide and  
10 0.01 to 30 parts by weight of a member selected from the  
group consisting of (A) liquid diene polymers, (B) epoxy  
compounds and (C) compounds having in the molecule both  
of (a) an ethylenic carbon-carbon double bond or a  
carbon-carbon triple bond and (b) a carboxylic acid,  
15 acid anhydride, acid amide, imido, carboxylic ester,  
amino or hydroxyl group per 100 parts by weight of the  
total of polyphenylene oxide and polyamide.

The present invention will be illustrated in  
more detail.

20 As polyphenylene oxide used in the present  
invention, the well-known ones may satisfactorily be  
used. It can easily be produced by the methods dis-  
closed in U.S. Patent Nos. 3,306,875, 3,337,501 and  
3,787,361. For example, it can be obtained by oxidation-  
25 polymerizing a phenol compound of the formula,



- 1 wherein R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, R<sub>4</sub> and R<sub>5</sub> are each a hydrogen,  
halogen atom, a hydrocarbon or substituted hydrocarbon  
group and one of them is a hydrogen atom, with oxygen  
or an oxygen-containing gas in the presence of an  
5 oxidation-coupling catalyst.

As specific examples of R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub>, R<sub>4</sub> and R<sub>5</sub>  
in the above formula, there may be given for example  
hydrogen, chlorine, fluorine, bromine and iodine atoms,  
and methyl, ethyl, propyl, butyl, chloroethyl, hydroxy-  
10 ethyl, phenylethyl, benzyl, hydroxymethyl, carboxyethyl,  
methoxycarbonyl ethyl, cyanoethyl, phenyl, chlorophenyl,  
methylphenyl, dimethylphenyl and ethylphenyl groups.

As specific examples of the phenol compound,  
there may be given for example phenol, o-, m- or p-  
15 cresol, 2,6-, 2,5-, 2,4- or 3,5-dimethylphenol, 2-  
methyl-6-phenylphenol, 2,6-diphenylphenol, 2,6-diethyl-  
phenol, 2-methyl-6-ethylphenol and 2,3,5-, 2,3,6- or  
2,4,6-trimethylphenol. These phenol compounds may be  
used as a mixture of them.

20 Also, phenol compounds other than those  
represented by the above formula, for example dihydric

1 phenols (e.g. bisphenol A, tetrabromobisphenol A,  
resorcinol, hydroquinone) may be copolymerized with  
those represented by the above formula.

The oxidation-coupling catalyst used in the  
5 oxidation-polymerization of the phenol compound is not  
particularly limited, and any of those acting as a  
catalyst on the polymerization can be used. As typical  
examples of the catalyst, there may be given for  
example catalysts comprising a cuprous salt and a  
10 tertiary amine (e.g. cuprous chloride-trimethylamine,  
cuprous acetate-triethylamine, cuprous chloride-  
pyridine), catalysts comprising cupric salt-tertiary  
amine and an alkali metal hydroxide (e.g. cupric  
chloride-pyridine-potassium hydroxide), catalysts  
15 comprising a manganese salt and a primary amine (e.g.  
manganese chloride-ethanolamine, manganese acetate-  
ethylenediamine), catalysts comprising a manganese  
salt and alcoholate or phenolate (e.g. manganese  
chloride-sodium methylate, manganese chloride-sodium  
20 phenolate) and catalysts comprising combination of a  
cobalt salt and a tertiary amine.

As specific examples of the polyphenylene  
oxide, there may be given, for example, poly(2,6,-  
dimethyl-1,4-phenylene oxide), poly(2-methyl-1,4-  
25 phenylene oxide), poly(3-methyl-1,4-phenylene oxide),  
poly(2,6-diethyl-1,4-phenylene oxide), poly(2,6-  
dipropyl-1,4-phenylene oxide), poly(2-methyl-6-allyl-  
1,4-phenylene oxide), poly(2,6-dichloromethyl-1,4-

1 phenylene oxide), poly(2,3,6-trimethyl-1,4-phenylene  
oxide), poly(2,3,5,6-tetramethyl-1,4-phenylene oxide),  
poly(2,6-dichloro-1,4-phenylene oxide), poly(2,6-  
diphenyl-1,4-phenylene oxide), and poly(2,5-dimethyl-  
5 1,4-phenylene oxide).

Copolymers of the phenol compounds also may  
be used.

Polyamide used in the present invention is  
one having a  $\text{-C-NH-}$  linkage in the main chain, and any



10 of the well-known ones which are fusible by heating can  
be used. Typical examples of polyamide include for  
example 4-nylon, 6-nylon, 6,6-nylon, 12-nylon, 6,10-  
nylon, polyamides resulting from terephthalic acid and  
trimethyl hexamethylenediamide, polyamides resulting  
15 from adipic acid and meta-xylylenediamine, polyamides  
resulting from adipic acid, azelaic acid and 2,2-bis-  
(p-aminocyclohexyl)propane and polyamides resulting  
from terephthalic acid and 4,4'-diaminodicyclohexyl-  
methane.

20 The blending ratio of polyphenylene oxide  
to polyamide is 5 to 95 wt %, preferably 30 to 70 wt %,  
of the former to 95 to 5 wt %, preferably 70 to  
30 wt %, of the latter. When polyamide is less than  
5 wt %, its effect to improve the solvent resistance  
25 is small, while when it exceeds 95 wt %, thermal  
properties such as heat distortion temperature tend to  
become poor.

1           As the liquid diene polymer used in the present  
invention, there may be given for example homopolymers  
of a conjugated diene and copolymers of the conjugated  
diene and at least one member selected from the group  
5 consisting of other conjugated dienes, olefins, aromatic  
vinyl compounds and acetylenic compounds, having a number  
average molecular weight of 150 to 10,000, preferably  
150 to 5,000. These homopolymers and copolymers can  
be produced, for example, by the well-known methods in  
10 U.S. Patent Nos. 4,054,612, 3,876,721 and 3,428,699.

As specific examples of the homopolymers of a  
conjugated diene and copolymers of fellow conjugated  
dienes, there may be given for example homopolymers of  
butadiene, isoprene, 1,3-pentadiene, cyclopentadiene,  
15 2,3-dimethylbutadiene, chloroprene or 2-phenylbutadiene,  
and copolymers of these fellow conjugated dienes.

Copolymers of a conjugated diene and an olefin  
include for example copolymers comprising the foregoing  
conjugated diene and at least one member selected from  
20 olefins consisting of ethylene, propylene, butene-1,  
isobutylene, pentene-1, hexene-1, heptene-1, octene-1  
and dodecene-1.

Copolymers of a conjugated diene and an  
aromatic vinyl compound include for example styrene/  
25 butadiene copolymers, isoprene/styrene copolymers,  
butadiene/isoprene/styrene copolymers, 1,3-pentadiene/  
styrene copolymers, butadiene/ $\alpha$ -methylstyrene copolymers,  
isoprene/ $\alpha$ -methylstyrene copolymers and butadiene/p-



1 hydroxystyrene copolymers.

Although the micro structure of the double bond of these liquid diene polymers contains a vinyl group, trans-1,4 structure and cis-1,4 structure in  
5 different proportions, all these polymers are included in the scope of the present invention independent of the micro structure.

As the epoxy compound used in the present invention, the well-known ones, for example (1) epoxy  
10 resins produced by condensing polyhydric phenols and epichlorohydrin in different proportions, (2) epoxy resins produced by condensing polyhydric alcohols and epichlorohydrin, (3) glycidyletherified products of monohydric phenols or monohydric alcohols, (4) glycidyl  
15 derivatives of amine compounds and (5) epoxidized products of higher olefins or cycloalkenes, can be used.

Typical examples of the epoxy resins (1) include for example condensates resulting from bisphenol  
20 A and epichlorohydrin (commercial products include for example Sumi-epoxy ELA-115, ELA-127, ELA-128, ELA-134, ESA-011, ESA-014, ESA-017 and ESA-019 produced by Sumitomo Chemical Co.), condensates resulting from resorcinol and epichlorohydrin, condensates  
25 from hydroquinone and epichlorohydrin, condensates resulting from tetrabromobisphenol A and epichlorohydrin and the glycidyletherified products of phenol novolak or cresol novolak (commercial products include

1 for example Sumi-epoxy ESCN-220 series products produced  
by Sumitomo Chemical Co.).

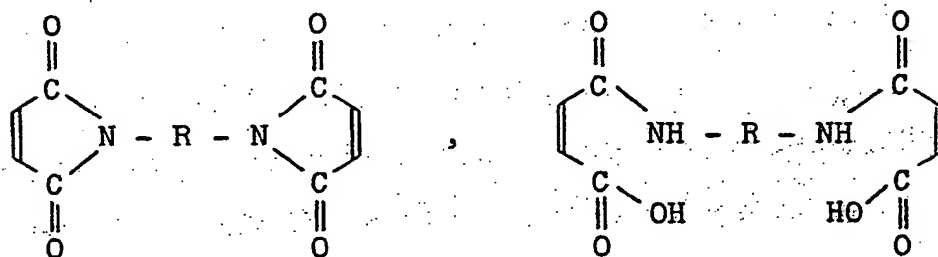
As typical examples of a polyhydric alcohol  
used for producing the epoxy resins (2), there may be  
5 given for example ethylene glycol, propylene glycol,  
butylene glycol, polyethylene glycol, polypropylene  
glycol, glycerin, trimethylolethane, trimethylolpropane  
and pentaerythritol.

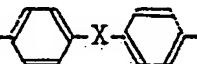
The glycidyletherified products (3) include  
10 for example phenyl glycidyl ether, butyl glycidyl ether  
and cresyl glycidyl ether. The glycidyl derivatives  
of amine compounds (4) are put on the market, for  
example, in the name of Sumi-epoxy ELN-125 (produced by  
Sumitomo Chemical Co.) which is a diglycidyl derivative  
15 of aniline.

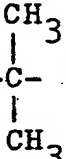
Further, condensates between dihydric phenols  
and epichlorohydrin having a fairly high molecular  
weight, for example those put on the market as Phenoxy  
resin (produced by Union Carbide Corp.), can also be  
20 used. Still further, other epoxidized compounds, for  
example epoxy derivatives of natural unsaturated oils  
(e.g. soybean oil) and those of the foregoing low  
molecular weight diene polymers, can be used.

As specific examples of the specified compound  
25 having both of (a) an ethylenic carbon-carbon double  
bond or a carbon-carbon triple bond and (b) a carboxylic  
acid, acid anhydride, acid amide, imido, carboxylic acid  
ester, amino or hydroxyl group, there may be given for

- 1 example maleic anhydride, maleic acid, fumaric acid, maleimide, maleic hydrazide and reaction products resulting from a diamine and maleic anhydride, maleic acid, fumaric acid, maleimide or maleic hydrazide for example compounds of
- 5 the formulae,



wherein R is an alkylene or arylene group having up to 20 carbon atoms or  (wherein X is -O-, -SO<sub>2</sub>-,

-CH<sub>2</sub>- or ); methyl nadic anhydride, dichloromaleic

- anhydride, maleic acid amide and natural fats and oils
- 10 (e.g. soybean oil, tung oil, castor oil, linseed oil, hempseed oil, cotton seed oil, sesame oil, rapeseed oil, peanut oil, camellia oil, olive oil, coconut oil, sardine oil); unsaturated carboxylic acids (e.g. acrylic acid, butenoic acid, crotonic acid, vinylacetic
- 15 acid, methacrylic acid, pentenoic acid, angelic acid, tiglic acid, 2-pentenoic acid, 3-pentenoic acid, α-ethylacrylic acid, β-methylcrotonic acid, 4-pentenoic acid, 2-hexenoic acid, 2-methyl-2-pentenoic acid, 3-methyl-2-pentenoic acid, α-ethylcrotonic acid,

- 1 2,2-dimethyl-3-butenic acid, 2-heptenoic acid, 2-octenoic acid, 4-decenoic acid, 9-undecenoic acid, 10-undecenoic acid, 4-dodecenoic acid, 5-dodecenoic acid, 4-tetradecenoic acid, 9-tetradecenoic acid, 9-hexa-
- 5 decenoic acid, 2-octadecenoic acid, 9-octadecenoic acid, eicosenoic acid, docosenoic acid, erucic acid, tetracosenoic acid, mycolipenic acid, 2,4-pentadienoic acid, 4-hexadienoic acid, diallylacetic acid, geranic acid, 2,4-decadienoic acid, 2,4-dodecadienoic acid, 9,12-
- 10 hexadecadienoic acid, 9,12-octadecadienoic acid, hexadecatrienoic acid, linoleic acid, linolenic acid, octadecatrienoic acid, eicosadienoic acid, eicosatrienoic acid, eicosatetraenoic acid, ricinoleic acid, eleostearic acid, oleic acid, eicosapentaenoic acid, erucinic acid,
- 15 docosadienoic acid, docosatrienoic acid, docosatetraenoic acid, docosapentaenoic acid, tetracosenoic acid, hexacosenoic acid, hexacodienoic acid, octacosenoic acid); esters, acid amides or anhydrides of these unsaturated carboxylic acids; unsaturated alcohols
- 20 (e.g. allyl alcohol, crotyl alcohol, methylvinylcarbinol, allylcarbinol, methylpropenylcarbinol, 4-pentene-1-ol, 10-undecene-1-ol, propargyl alcohol, 1,4-pentadiene-3-ol, 1,4-hexadiene-3-ol, 3,5-hexadiene-2-ol, 2,4-hexadiene-1-ol, alcohols of the formulae  $C_nH_{2n-5}OH$ ,
- 25  $C_nH_{2n-7}OH$ ,  $C_nH_{2n-9}OH$  (wherein n is a positive integer up to 30), 3-butene-1,2-diol, 2,5-dimethyl-3-hexene-2,5-diol, 1,5-hexadiene-3,4-diol, 2,6-octadiene-4,5-diol); unsaturated amines resulting from replacing the

1 -OH group of the above unsaturated alcohols with  $\text{-NH}_2$   
group; and compounds derived from said low molecular  
weight polymers (average molecular weight, 150 to  
10,000, preferably 150 to 5,000) of a diene compound  
5 (e.g. butadiene, isoprene) or high molecular weight  
polymers (average molecular weight, more than 10,000)  
of the diene compound, for example adducts resulting  
from the foregoing polymers and maleic anhydride or  
phenols, and the amino, carboxylic or hydroxyl group-  
10 substituted products of the foregoing polymers. It is  
a matter of course that the compound of a specified  
structure defined in the present invention includes  
those having not less than two of the functional groups  
of the group (a) (which may be the same or different)  
15 and not less than two of the functional groups of the  
group (b) (which may be the same or different) at the  
same time.

The foregoing compounds (A), (B) and (C) may  
be used alone or in combination. The total amount of  
20 the compounds is 0.01 to 30 parts by weight, preferably  
0.1 to 20 parts by weight, more preferably 0.3 to 10  
parts by weight, based on 100 parts by weight of a  
mixture of polyphenylene oxide and polyamide. When the  
amount is less than 0.01 part by weight, the effect of  
25 the present invention tends to be small, while amounts  
more than 30 parts by weight tend to lower the softening  
temperature.

In the present invention, it is desirable to

- 1 add rubbery high molecular weight polymers in order to further elevate the impact strength. The rubbery high molecular weight polymers include natural and synthetic polymer materials showing elasticity at room temperature.
- 5 As the specific examples of the rubbery polymer, there may be given for example natural rubbers, butadiene polymers, butadiene/styrene copolymers (including random copolymers, block copolymers and graft copolymers), isoprene polymers, chlorobutadiene polymers,
- 10 butadiene/acrylonitrile copolymers, isobutylene polymers, isobutylene/butadiene copolymers, isobutylene/isoprene copolymers, acrylic ester polymers, ethylene/propylene copolymers, ethylene/propylene/diene copolymers, thiokol rubber, polysulfide rubber, polyurethane
- 15 rubber, polyether rubber (e.g. polypropylene oxide) and epichlorohydrin rubber.

These rubbery polymers may be produced by any of the well-known methods (e.g. emulsion polymerization, solution polymerization) using any of the well-known

- 20 catalysts (e.g. peroxides, trialkylaluminum, lithium halides, nickel catalysts). These rubbery polymers may be used independent of the degree of crosslinking, the proportion of the cis structure, trans structure and vinyl group contained in the micro structure and the
- 25 average particle size.

Any copolymer of random copolymers, block copolymers, graft copolymers and the like may be used as the rubbery polymer.

1 Further, in producing these rubbery polymers, monomers  
such as other olefins, dienes, aromatic vinyl compounds,  
acrylic acid, acrylic esters and methacrylic esters may  
be added as an additional component for copolymeriza-  
5 tion. And the copolymerization may be carried out by  
any of random copolymerization, block copolymerization,  
graft copolymerization and the like. As specific  
examples of the monomers, there may be given for example  
ethylene, propylene, styrene, chlorostyrene,  $\alpha$ -methyl-  
10 styrene, butadiene, isoprene, chlorobutadiene, butene,  
isobutylene, methyl acrylate, acrylic acid, ethyl  
acrylate, butyl acrylate, methyl methacrylate and  
acrylonitrile. Further, partially modified products of  
the products of the rubbery polymer of the present  
15 invention, for example polybutadiene modified at the  
end of the chain with a hydroxyl or carboxylic group  
and partially hydrogenated styrene/butadiene block  
copolymers, are included in the scope of the present  
invention.

20 The amount of the rubbery polymer used in 5  
to 100 parts by weight, preferably 5 to 50 parts by  
weight, based on 100 parts by weight of a mixture of  
polyphenylene oxide and polyamide. When the amount is  
less than 5 parts by weight, the effect of the rubbery  
25 polymer to improve impact resistance is poor. While  
when the amount is more than 100 parts by weight, the  
impact resistance is much improved, but amounts of not  
more than 100 parts by weight are desirable,

1 considering balance between the impact resistance and  
other physical properties.

The addition of styrene polymer for a further  
improvement in the processability of resin is one of the  
5 desirable embodiments. Specific examples of the styrene  
polymer include for example styrene homopolymer,  
copolymers of styrene and other vinyl compounds and  
rubber-reinforced polystyrene, the so-called high impact  
polystyrene.

10 A method for producing the resin compositions  
of the present invention is not particularly limited,  
and the conventional methods are satisfactorily employed.  
Generally, however, melt-blending methods are desirable.  
A time and a temperature required for melt-blending are  
15 not particularly limited, and they can properly be  
determined according to the composition of the material.  
The temperature somewhat varies with the blending ratio  
of polyphenylene oxide to polyamide, but generally it  
is within a range of 150° to 350°C. A prolonged time is  
20 desirable for mixing, but the deterioration of the resin  
composition advances. Consequently, the time needs to  
be determined taking into account these points.

Any of the melt-blending methods may be used,  
if it can handle molten viscous mass. The method may  
25 be applied in either of batchwise form or continuous  
form. Specifically, extruders, Banbury mixers, rollers,  
kneaders and the like may be exemplified.

Next, the present invention will be illustrated



- 1 in more detail with reference to the following examples,  
which are not however to be interpreted as limiting the  
invention thereto.

Examples 1 to 5

- 5           2,6-Dimethylphenol was dissolved in a mixture  
of toluene and methanol, and manganese chloride and  
ethylene diamine were added thereto. Thereafter,  
oxidation was carried out under an oxygen atmosphere  
to obtain poly-(2,6-dimethyl-1,4-phenylene oxide)  
10 (intrinsic viscosity, 0.55 dl/g in chloroform). The  
polyphenylene oxide thus obtained, polyamide (nylon  
6,6, produced by Toray Co.) and liquid polybutadiene  
(SUMIKAOIL 150, produced by Sumitomo Chemical Co.;  
number average molecular weight, about 1,700; cis-1,4  
15 structure more than 75 %, vinyl structure less than  
2 %) were mixed in proportions described in Table 1  
and kneaded at 250° to 300°C for 5 minutes on  
Brabender Plastograph. The Izod impact values  
(according to ASTM D-256) of the kneaded products were  
20 shown in Table 1.

Comparative example 1

Operation was carried out in the same manner  
as in Example 1 except that the liquid polybutadiene was  
not used. The result was shown in Table 1.

Table 1

	Polyphenylene oxide/ nylon 6,6 (weight ratio)	Liquid polybutadiene (PHR*)	Izod impact value (with notch) (kg·cm/cm <sup>2</sup> )
Example 1	7/3	1	8.6
Example 2	6/4	3	9.3
Example 3	5/5	1	12.1
Example 4	4/6	0.5	11.9
Example 5	3/7	0.7	13.3
Comparative example 1	7/3	0	2.7

\* PHR : Part by weight per 100 parts by weight of the total of  
polyphenylene oxide and polyamide.

1 Example 6, Comparative example 2

Polyphenylene oxide (44 parts by weight),  
polyamide (44 parts by weight), liquid polybutadiene  
(1 part by weight), all of which were the same as used  
5 in Example 1, and a butadiene/styrene copolymer (12  
parts by weight, Solprene 1204, produced by Asahi Kasei  
Co.) were mixed and kneaded at 280°C for 5 minutes on  
Brabender Plastograph. The Izod impact value (according  
to ASTM D-256) was 16.3 kg·cm/cm<sup>2</sup>. For comparison  
10 (Comparative example 2), the same operation as above  
was repeated except that liquid polybutadiene was not  
used. The Izod impact value of the kneaded product was  
2.7 kg·cm/cm<sup>2</sup>.

Examples 7 to 14

15 The same poly-(2,6-dimethyl-1,4-phenylene  
oxide) and polyamide as used in Example 1 and each of  
the epoxy compounds in Table 2 were mixed and kneaded  
at 250° to 300°C for 5 minutes on Brabender Plastograph.  
The Izod impact value of the kneaded product was  
20 measured according to ASTM D-256 in order to show the  
mechanical strength, and the heat distortion temperature  
of the product was measured according to ASTM D-648 in  
order to show the heat resistance. The results were  
shown in Table 2.

25 Comparative example 3

Operation was carried out in the same manner

1 as in Example 7 except that the epoxy compound was not  
used. The result was shown in Table 2.

It is apparent from Table 2 that the impact  
resistance is improved as compared with the comparative  
5 example by adding the epoxy compounds according to the  
present invention.

Table 2

	Polyphenylene oxide/nylon 6,6 (weight ratio)	Specified compound		Izod impact value (kg.cm/cm <sup>2</sup> )	HDT (°C)
		Kind	Amount (PIR)		
Example 7	5/5	Sumi-epoxy ELA-128	1	10.3	135
Example 8	4/6	Phenoxy resin	1	9.3	101
Example 9	4/6	Epoxidized soybean oil	3	9.1	97
Example 10	3/7	2-Ethylhexyl glycidyl ether	0.5	8.3	95
Example 11	7/3	Polyethylene glycol diglycidyl ether	2	7.9	175
Example 12	2/8	Neopentyl glycol diglycidyl ether	5	11.3	79
Example 13	6/4	Glycerin diglycidyl ether	3	10.9	143
Comparative Example 3	5/5	None	-	4.1	131

(Note) HDT : Heat distortion temperature

1 Examples 14 to 21

The same polyphenylene oxide and polyamide as used in Example 1 and each of the compounds shown in Table 3 were mixed and kneaded at 250° to 300°C for 5 minutes on Brabender Plastograph. In order to know the degree of improvement in solvent resistance, the kneaded product was extracted with chloroform to separate polyphenylene oxide. Also, the Izod impact value of the kneaded product was measured according to 10 ASTM D-256 in order to know mechanical strength, and the heat distortion temperature (HDT) was measured according to ASTM D-648 in order to know heat resistance. The results were shown in Table 3 together with the result of Comparative example 4 using no specified compound.

15 It is apparent from Table 3 that the method of the present invention improves the graft percentage, solvent resistance and impact resistance as compared with the comparative example.

Table 3

	Poly-phenylene oxide/nylon 6,6 (weight ratio)	Specified compound		Amount of chloroform-extract (wt %)	Izod impact value (with notch) (kg·cm/cm <sup>2</sup> )	HDT (°C)
		Kind	Amount (PHR)			
Example 14	5/5	Adduct (I) of liquid polybutadiene and maleic anhydride #1	1	0	10.3	142
Example 15	7/3	Adduct (II) of liquid polybutadiene and maleic anhydride #2	3	0	7.5	175
Example 16	4/6	Linseed oil	1	0	11.1	97
Example 17	7/3	Maleic anhydride	1	2.2	6.5	175
Example 18	6/4	Linoleic acid	0.7	0	6.1	151
Example 19	5/5	Oleyl alcohol	3	0	8.9	142
Example 20	4/6	Adduct of liquid polybutadiene and phenol #3	1.5	0	9.2	99
Example 21	2/8	Linolenylamine	0.8	0	8.3	81
Comparative example 4	7/3	None	-	25	2.7	174

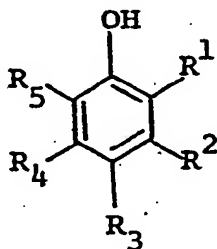
- \*1 Product obtained by addition of 1,4-polybutadiene (100 parts by weight; average molecular weight, about 8,000) to maleic anhydride (25 parts by weight).
- \*2 Product obtained by addition of 1,4-polybutadiene (100 parts by weight; average molecular weight, about 300) to maleic anhydride (10 parts by weight).
- \*3 Product obtained by addition of 1,4-polybutadiene (100 parts by weight; average molecular weight, about 1,700) to phenol (about 50 parts by weight).



CLAIMS

1. A resin composition comprising (1) a resin comprising 5 to 95% by weight of a polyphenylene oxide and 95 to 5% by weight of a polyamide and (2) 0.01 to 30 parts by weight of (A) a liquid diene polymer, or (B) an epoxy compound or (C) a compound having in the molecule both (a) an ethylenic carbon-carbon double bond or a carbon-carbon triple bond and (b) a carboxylic acid, acid anhydride, acid amide, imido, carboxylic acid ester, amino or hydroxyl group, per 100 parts by weight of the total of polyphenylene oxide and polyamide resin (1).

2. A resin composition according to claim 1, wherein said polyphenylene oxide is obtained by oxidation-polymerizing a phenol compound of the formula,



wherein  $R_1$ ,  $R_2$ ,  $R_3$ ,  $R_4$  and  $R_5$  are each hydrogen or halogen or a hydrocarbon or substituted hydrocarbon group, at least one being hydrogen, with oxygen or an oxygen-containing gas in the presence of an oxidation-coupling catalyst.

3. A resin composition according to claim 1 or 2 wherein the weight ratio of polyphenylene oxide to polyamide is 30 - 70/70 - 30.

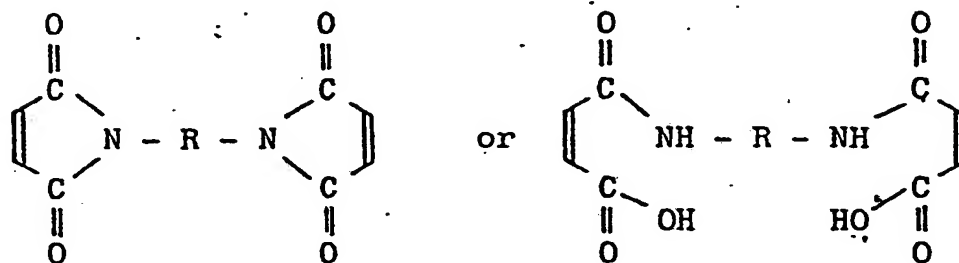
4. A resin composition according to any one of the preceding claims, wherein said liquid diene polymer has a number average molecular weight of 150 to 10,000.

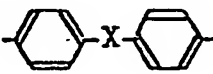
5. A resin composition according to claim 4, wherein the liquid diene polymer is a homopolymer of butadiene, isoprene, 1,3-pentadiene, cyclopentadiene, 2,3-dimethyl-butadiene, chloroprene or 2-phenylbutadiene, or a copolymer of at least one of the above-mentioned conjugated dienes, and at least one of ethylene, propylene, butene-1, isobutylene, pentene-1, hexene-1, heptene-1, octene-1 and dodecene-1, styrene/butadiene copolymers, isoprene/styrene copolymers, butadiene/isoprene/styrene copolymers, 1,3-pentadiene/styrene copolymers, butadiene/ $\alpha$ -methylstyrene copolymers, isoprene/ $\alpha$ -methylstyrene copolymers and butadiene/p-hydroxystyrene copolymers.

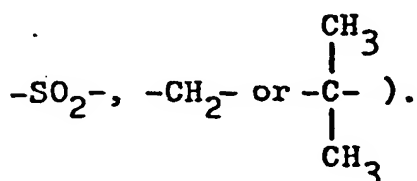
6. A resin composition according to any one of claims 1-3, wherein said epoxy compound is (1) an epoxy resin produced by condensing a polyhydric phenol and epichlorohydrin in different proportions, (2) an epoxy resin produced by condensing a polyhydric alcohol and epichlorohydrin, (3) a glycidyletherified product of a monohydric phenol or monohydric alcohol, (4) a glycidyl derivative of an amine compound or (5) an epoxidized product of a higher olefin or cycloalkene.

7. A resin composition according to any one of claims 1-3, wherein said compound (C) is maleic anhydride, maleic acid, fumaric acid, maleimide, maleic hydrazide, methylnadic anhydride, dichloromaleic anhydride, maleic acid amide, a natural fat or oil, an unsaturated carboxylic acid ester, acid amide or an anhydride of an unsaturated carboxylic acid, an unsaturated alcohol, an unsaturated amine, a reaction product of a diamine with maleic anhydride, maleic acid, fumaric acid, maleimide or maleic hydrazide, an adduct of a diene polymer with maleic anhydride and phenol or an amino, carboxylic or hydroxyl group-substituted diene polymer.

8. A resin composition according to claim 7, wherein said compound (C) is one represented by the formulae,



wherein R is an alkylene or arylene group having up to 20 carbon atoms, or  (wherein X is -O-,



9. A resin composition according to

any one of the preceding claims wherein the amount of said compound (A), (B) or (C) is 0.1 to 20 parts by weight per 100 parts by weight of the total of polyphenylene oxide and polyamide resin (1).

10. A resin composition according to claim 9, wherein the amount of said compound (A), (B) or (C) is 0.3 to 10 parts by weight.

11. A resin composition according to any one of the preceding claims, wherein a rubbery polymer is added in amount of 5 to 100 parts by weight per 100 parts by weight of the total of polyphenylene oxide and polyamide resin (1).

12. A resin composition according to claim 11, wherein the amount of rubbery polymer is 5 to 50 parts by weight.



DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
A	<u>GB - A - 1 110 195</u> (G.E.) * Claim 1 * --	1-3	C 08 L 71/04 77/00// C 08 G 81/00
A	<u>US - A - 3 660 531</u> (R.L. LAUHLAN et al.) --	1, 5, 11, 12	
A	CHEMICAL ABSTRACTS, vol. 78, no. 16, 23-04-1973, page 39, abstract 98533j, Columbus, Ohio, US & <u>JP - A - 72 20 243</u> (ASAHI CHEMICAL INDUSTRY CO.LTD.) (28-09-1972) --	1-3	TECHNICAL FIELDS SEARCHED (Int. Cl.)  C 08 L 71/04 77/00 C 08 G 81/00
A	CHEMICAL ABSTRACTS, vol. 78, no. 8, 26th February, 1973, page 37, abstract no. 44515m, Columbus, Ohio, US. & <u>SU - A - 350 806</u> (V.M. SHILENKO et al.) (13-05-1972) --	1, 6	CATEGORY OF CITED DOCUMENTS  X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons  &: member of the same patent family. corresponding document
A	<u>DE - A - 1 520 019</u> (GENERAL ELECTRIC) * Claims; page 2, paragraph 1 * ---	1	
The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
The Hague	13-11-1980	HALLEMEESCH	

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